620.5
EE

OXFORD, O.

ENGINEERING-EDUCATION

Bulletin of the
Society for the Promotion of Engineering Education

Vol. IV LANCASTER, PA., FEBRUARY, 1919 No. 6

Every Highway Engineer Should Have

American Highway Engineers' Handbook

ARTHUR H. BLANCHARD, Editor-in-Chief, and Seventeen Associate Editors

Includes sections treating the several types of roads and pavements, featuring:

Characteristics of materials and standard methods; construction methods and the use of mechanical appliances; authoritative specifications covering materials; reasons for failures; methods of maintenance; cost data and a bibliography of selected references. It is the BEST book in its field.

xxv+1658 pages. 4¼ by 7. Fully illustrated. Flexible "Fabrikoid" binding. $5.00 net.

Send for a copy for ten days' FREE EXAMINATION

Our Special Subject Catalog 5e is of interest to highway engineers. Send for it.

JOHN WILEY & SONS, Inc.

Dept. C, 432 Fourth Avenue **New York City**

S. P. E. E. 2–19

Entered as second class-matter, August 24, 1912, at the Post Office at Lancaster, Pennsylvania, under the Act of August 24, 1912

News of the Current Engineering Progress

is a necessary part of the education of the engineering student. Especially now, when changes are coming with lightning-like rapidity and the whole field of engineering endeavor is dynamic with possibilities for the man who is thoroughly equipped to apply scientific principles to the solution of the tremendous new construction and industrial problems of the Readjustment Period following the war.

Whatever the Engineering Field in which you intend to specialize—

civil, electrical, chemical, metallurgical, electric transportation, coal mining, metal mining, power generation, machine design and construction, the selling of electrical supplies or service—

There's a McGraw-Hill Engineering Publication

ready to serve you promptly, fully and accurately with all the important new developments, advances in practice and improvements in equipment. Each is a recognized authority in its field, with wide circulation and influence, standing for the highest professional ideals and devoted to the stimulation, reflection and interpretation of the constructive thought that will lead its readers forward. These publications are listed below. The field of each is indicated in its title. Sample copies and subscription terms furnished on application.

McGRAW-HILL CO., Inc.

10th Ave., at 36th St.
NEW YORK

Power
Coal Age
American Machinist
Electric Railway Journal
Electrical World
Electrical Merchandising
Engineering News-Record
Engineering and Mining Journal
Chemical and Metallurgical Engineering

When Your Students

Secure jobs that include **"testing,"** they are very likely to be required to measure insulation resistance with a

Megger Testing Set

Therefore why not make them familiar with the **"Megger Method,"** before leaving school or college?

Sooner or later, we believe a Megger will be found in each well equipped Engineering Laboratory; and shall be glad to do our part by supplying full particulars **(including catalog)** upon request.

JAMES G. BIDDLE

1211-13 Arch Street PHILADELPHIA

The Leeds & Northrup Co.

Electrical Measuring Instruments of Precision

for use in Engineering Laboratories

Our publications contain much scientific information of interest to Engineers. If you are not receiving this literature may we place your name upon our mailing list?

4910 Stenton Ave. **PHILADELPHIA**

PHYSICS

FOR

TECHNICAL STUDENTS

By WM. B. ANDERSON, Ph.D.

[Professor of Physics, Oregon State College

Just Out

Part Two

SOUND, LIGHT, ELECTRICITY AND MAGNETISM

457 pages, 6 x 9, illustrated.....**$2.00**

In Press

ONE-VOLUME EDITION.....$3.00

Published Previously

Part One

MECHANICS AND HEAT

341 pages, 6 x 9, illustrated.....**$2.00**

The development of notes which Dr. Anderson used through several years. These notes were prepared from the point of view of the class instructor as well as of the lecturer, and consequently the book makes a well-rounded text for first courses in college physics.

The series emphasizes those applications of the principles of mechanics, heat, sound, light and electricity, which should be of special value to students of engineering and agriculture.

Every principle treated in the text is brought up, as far as possible, in a problem, so that in working all of the problems a review of practically the entire course is obtained.

Send for these books on approval

McGraw-Hill Book Co., Inc.

239 West 39th Street **NEW YORK**

BULLETIN

OF THE

Society for the Promotion of Engineering Education

Published under the supervision of the Publication Committee:

John F. Hayford, Milo S. Ketchum, F. L. Bishop, *Editor.*

Address all communications to the Editor, University of Pittsburgh, Pittsburgh, Pa.

VOL. IX LANCASTER, PA., FEBRUARY, 1919 NO. 6

TABLE OF CONTENTS

The Training Required for Engineers. By Major General William M. Black 187
Discussion 206
Editorial 245

THE TRAINING REQUIRED FOR ENGINEERS.

BY MAJOR GENERAL WILLIAM M. BLACK,

Chief of Engineers, U. S. Army.

Mr. President and Gentlemen: I cannot say I have a paper, but I have something I want to say to you. The subject that is put down is the training required for army engineers. I think, perhaps, I had better make it a little more specific. We have two distinct classes of engineers employed on war work, one is the combatant class and the other the non-combatant class. That perhaps I can illustrate by telling you of two distinct kinds of organization that we have in the Army itself—of engineers. We have our sapper troops and the troops who are liable to be employed at the front in the theater of opera-

tions and under fire, and who must work under orders of the general commanding the particular section, and who frequently do have to take a place directly in the line of battle. Those are combatant engineers.

Then we have another class of troops who, in France, are organized under service of supply,—"S.O.S." as it is termed. Those men are not expected to be under fire. They are just as essential as the first class, because on the S.O.S.—on the ability of the S.O.S. to supply the front is determined the possibility of movement,—the possibility of action. All the immense mass of supplies constantly required must be handled by the S.O.S., so that is just as important a factor, just as essential a factor as the actual fighting troops at the front; but the engineers of that particular class, those in the service of transportation and the men in the service of production are non-combatant troops.

And it is illustrated in the way the regiments are made up. In combatant engineer troops, the officers who are all engineers by profession, and the non-commissioned officers are selected from the military point of view,—the ability to control men in action, as shown by their ability after they get into service, if there has not been a chance to test them before as to their particular military qualities when candidates for commissions and for the non-commissioned officer grades for the combatant troops.

For the non-combatant troops the non-commissioned officers are selected simply from a knowledge of the work they have done in civil life. For example, when we take a railway operating regiment we select for the officers the officials who held positions in railways in civil life,—superintendents, train dispatchers, and so forth, and we give them a rank somewhat in accordance with their relative positions in those civil offices. The same in the shop regiments,—work in the roundhouse or in the shops for the repair of locomotives or train material, there again the commissioned and non-commissioned officers, although given military titles, these are in accordance with

the work they have done in civil life of the same character as that which they have to do in military life. So there is that marked distinction between the combatant engineer in the war and the non-combatant; but what I am talking about now is more particularly the training required for the combatant engineers.

In order that you might appreciate the kind of training and why we think this certain kind of training is necessary, it might be well to review a little the duties of the combatant engineer. The engineering profession of our country was most patriotic in its response to the call of the country to arms,—almost to a man they offered their services; but many came to me and said, "I am an expert in concrete construction and I offer my services as a constructor of concrete." Another man would say, "I am an expert in water supply," and another, "an electrical expert," and "I offer my services in that capacity to the Government." The answer I was compelled to make to all of those gentlemen was that the Government does not want a one-sided expert; the Government for its combatant troops, wants a man who is able and ready to do anything in the wide world he is called upon to do, because that is the only kind of a man we can use at the front. Not that we undervalue expert knowledge at all, and do not think it quite necessary, but that there is very little room for specialists. It is perfectly manifest, if you think of it, that you cannot have on your staff right at the front a large number of individuals who sit around and wait, say, until an electrical problem comes up, and then one jumps up and does it, or until a water supply problem comes up—you cannot do that. But you have to have a class of men sufficiently all-around engineers to be able to do all ordinary tasks of that kind that fall to the Army; and, of course, at the front, ordinary and not extraordinary tasks are those presented for hurried execution. I would say that the need for specialists at the front is exceedingly limited.

A man must be, first of all, an all-around engineer, capable

of tackling anything, understanding all the principles, all the applied branches of engineering, although not necessarily a great specialist or expert in any one. Of course, if he is an expert in any one, in addition to that, so much the better—by all means; but best of all is to have the all-around training.

Have you thought what these combatant engineers have to do and have done at the front? Suppose we begin right out at the front. The men have taken up a position, and the first thing these engineers have to do is to go along the very front line and see where the troops have been placed and get that line organized then for defense,—move these men a little further forward and those a little further back, take the hastily dug trenches and form them into an organized line of trenches, and then put outside of that the obstacles, then they make connecting lines of trenches, then other positions to the rear, and so on. That is purely military work and in this trench warfare a knowledge of geology is of great value. Also you have to have drainage; you have to have your water supply; you have to have sanitary engineering right in that front line work.

An attack is going to be made. Up come your engineers to clear away obstacles, and the placing them or the clearing them away does not constitute a good life insurance risk, gentlemen. There comes in there not only personal bravery, but every man has to have expert knowledge of explosives,—how to make the smallest amount of explosives placed at a certain point produce the effect required, because if you do not get that effect it means the sacrifice of human life. That is their work.

The rush is made, the army goes forward immediately, the engineer must see that the roads which have been torn up by shell fire and mines are made practicable for transportation, for, of course, transportation must keep up with the army all the time, there must be movement of men, of materials and of supplies all the time. He must see that his light railway system is carried forward; that any of the enemy's railway

which has been captured is put in good condition and position and carried forward; railway operation and railway maintenance must be carried out, and they are good problems. Taking these last two advances over there, frequently the only road material available was the material that the boches had made in the towns by knocking down the houses. I wish I could tell you in detail much about the roads and their traffic regulations. Some roads were two-way roads and others one-way. In certain cases new roads had to be constructed miles in length, and in repairing these roads and building them the material was brought in motor trucks,—carried to a point where needed. The trucks sometimes had to go in a long detour and then back to take up the material for construction again. A small part of a main railway line is captured, and that the boches have very carefully destroyed by putting a charge of explosive under each rail joint and blowing the whole business out, so if the rails were not carried away bodily, only something like forty per cent. of the whole track material was left, the ties having been burned or carried away entirely. So you have railway construction and maintenance, and then in the theater of operations these same engineers at the front must operate the trains.

It may be in this warfare that we find that mining operations are necessary, and there comes the need of the special knowledge. This work is attended by all the risks of mining you would have in ordinary civil pursuits plus the risk of some fellow trying to blow you up while at it. This calls for the necessity of working at night, so that always in the rear front line it was necessary to carry on a lighting plant and establishing lighting systems. Shops have to be run, and means of carrying power lines from a generating plant far enough from the rear to be fairly well protected from shell fire must be had. Through all this there is necessity for constructions which have to be proof against heavy explosive shells, calling for resourcefulness and knowledge in construction work, and all to be done very quickly. Immediately in

the rear of the front lines whole villages had to be made bomb proof and had to be concealed from the enemy. They had to be supplied with sewers, with water and with lights.

So right in that front line work there is almost every possible class of engineering called for and this has to be done by the combatant engineers.

Farther to the rear there are whole villages that have to be constructed. I had a note from one engineer who said he was making a hospital for 25,000 beds, which entailed the building of over 1,000 separate houses and some 50 miles of pipe for sewage, water, and the different electric transmission lines. In the great depots for supplies long lines of warehouses have been constructed, each one supplied with a railway track and with a roadway,—the railway track on one side and the road on the other, all lighted electrically, all supplied with water and all supplied with every facility for use. In connection with those, there were great railway yards for the classification of the trains.

Then you come to the ports, and the ports themselves had to be constructed. In many cases dredging had to be done and piers had to be dug; in many cases a thousand or a million square feet of storage space and miles of trackage had to be provided. That S.O.S. service was in part performed by non-combatants, but in part by combatants because the possibility of changes incident to all plans has to be provided for in the army also. It is better to have an excess of combatant engineers so there may be greater flexibility in the organization.

I have not mentioned the forestry troops, and I can tell you rather an interesting thing that occurred in connection with some of these troops over there who did not have time to get much military training on this side. In answering a hurry call sufficient training was given only to get the men organized to drill them enough to get on and off a train or boat in an orderly manner, and for instruction to the officers in how to make out the necessary papers to supply their men. The troops were supposed to go back into the woods and do

exactly what they had been doing on this side, and non-commissioned officers were over them in the same relations as foremen, etc., as on this side. But in sending those troops over, one battalion was in a transport that was torpedoed off the north of Ireland, and they lost all their clothing, tools and equipment. When they arrived in France they had to wait to be equipped. They then went to a training camp at Angers. This training camp was a training camp for the combatant engineer troops and there the men were given a very severe course of training for combatant work. I wish you gentlemen could have seen that kind of training. I never saw anything so well calculated to make a man all that he possibly could be in efficiency as that training which was given to our men,—in coördination of mind and muscle and the development of the body to its highest degree of efficiency the work was wonderful. I never saw such an exhibition of human endeavor and "pep" as was found at Camp Lee, for example, under Colonel Peterson, who will shortly be dean of our new school at Camp Humphreys. That kind of military training you would not have supposed to be strictly necessary for this non-combatant unit, but these men had been sent to Angers, and the commanding officer gave them the regular training of the camp for the period of their stay. The photographs taken of them drawn up in formation at the time they arrived there, and again just before they left, after their equipment had been received, show an enormous gain in physical form. But these men then went out into the woods, and what was the result? That battalion immediately made a greater output of timber than any other, simply because it had had this training. Individual training and training in team work gave this result.

So we have, then, those two classes of work for our engineers, and you can see from the duties that I have outlined that for war work the officers must have a very broad foundational training as engineers. They cannot be allowed to specialize in anything unless they have this basis on which

the specialty can be founded, they must know the general principles of engineering through all branches.

We, in our corps, have been fortunate in our preparation for war, and I think that the country has been fortunate too, not so much perhaps through forethought as through accident, in having allotted to the custody of the Corps of Engineers a large proportion of civil work undertaken by the government in the time of peace. Had it not been for this civil work, our army men could not have had the training that was necessary in the war. There is very little work in peace time for the combatant engineer in the army itself—in the army proper, and if we were confined to that class of work, war time would often find us in the position of the man who had studied medicine but never practised it, or the man who had studied law and never tried a case before the court; we would have been perfectly worthless for the work we had to do. You remember one of George Eliot's novels, in which she speaks of a gentleman who was collecting material for a very erudite work. He made notes and notes until he found one day to his surprise that he was getting on in years, and if he was ever to write the book which he had made his life's purpose he would have to begin. Then he tried to use his notes and found that he had been collecting notes so long that he could not do anything else. And that is true of a course of engineering without practice. You have to practice or your study is wasted.

So it is very fortunate that Congress has intrusted to the Corps of Engineers of the Army the enforcement of the laws for the protection of navigable waters and has charged it with a large amount of civil work in connection with rivers and harbors, and other federal work. Incidentally, when the government has work of that character, the army engineer is well fitted to help the United States, for they don't have to hire him for a large figure and can trust him to devote himself to the nation's interests because he has no other axes to grind.

As an illustration of the variety in the work of the army

engineers, I will name some of the lines of work that have fallen to me as a part of my official duties—not as a unique experience but as typical of the kind of work which a military engineer must do.

My first duty in the field after graduation at the Military Academy and service with the Battalion of Engineers started in 1880, and in 1880 and 1881 I was employed as assistant in the construction of locks, and fixed and movable dams on the Great Kanawha and Ohio Rivers.

In 1881 and 1882 as assistant in the Philadelphia District, and had to do with questions of river regulation, control of ice flow and harbor lines.

From September, 1883 to December, 1886, I was instructor at the Military Academy in Practical Military Engineering, and on duty with engineer troops.

From January, 1887, to November, 1891, in the District of Florida I was employed on the improvement of the mouth of St. Johns River involving the construction of jetties, improvement of the channel of St. Johns River by dredging and regulations, improvement of other rivers in Florida, hydrographic surveys for harbors in Florida which necessitated study of tides and tidal action, and in clearing away obstructions in various rivers. Incidentally it became necessary to design and construct a sternwheel boat which should be capable of snagging, pile driving, and hydraulic dredging.

From 1891 to 1895 I was on duty as instructor in civil engineering at the U. S. Engineer School and in command of a company of engineers.

From 1895 to 1897 on duty in the office of the Chief of Engineers in charge of the Personnel and Fortification Branch and during this period had to do with the projects for and design of permanent seacoast works.

From 1897 until May, 1898, as Engineer Commissioner of the District of Columbia, all problems of municipal engineering came before me, among which were the design of a system of street extensions for the District of Columbia, plans for

the abolition of railroad grade crossings in the city of Washington, and securing plans for the Connecticut Avenue bridge across the Rock Creek Valley.

Then came the Spanish War with experience in the field as Engineer Officer in the Porto Rico campaign. From 1899 to 1901 I was Engineer Officer on the staff of General Ludlow and later of General Wood in Havana. As such, I had charge of all municipal work in the city of Havana including the cleaning and reconstruction of the streets and design of a sewerage system. Later, to these duties was added the supervision of public works on the island of Cuba. Then came another tour of duty with a Battalion of Engineers and in command of the engineer post-graduate school.

Following that was a tour of duty in Panama inspecting the work then being carried on by the new Canal Company.

Following that came a tour of duty at Portland, Me., involving the design and execution of works of river and harbor improvement, construction of fortification and numerous reinforced concrete bridges.

In 1906 I was again sent to Havana and made Advisor of the Department of Public Works, as such having charge of all classes of public works on the island, including those of sanitation, water supply and lighthouse construction.

Following that duty, in 1909 came a tour of duty in New York City, where all the many problems connected with the river and harbor improvement and the enforcement of the laws for the protection of navigation had to be met. During this tour of duty was carried on the design and construction of the lock and dam of Troy, and the grappling with the many legal problems involved with that procedure, also the problems of raising the Maine from Havana Harbor. In addition, there was extensive work in connection with the land defense of our seacoast cities, and also an opportunity for investigation and report on the problems of sewage disposal in New York. During all of these various tours of duty the enforcement of the laws for the protection of the navigable

waters of the United States presented interesting problems of engineering and economic policy.

Now, that was one man's experience extending over a number of years, so you can see if one is called upon to do all that, he must have a broad foundation upon which to build. The supply of army engineers was for many years limited to graduates of the Military Academy at West Point. That school was founded in 1802. The act of March 16, 1802, authorized the organization of a separate Corps of Engineers to be stationed at West Point and to constitute a Military Academy. Consequently, the instruction there was always laid out to get the best results in training men for engineers. The weights given to the various studies and the classification of the cadets on final graduation and for commissions in the Army were based on that fundamental consideration, so that the graduation standing of a man at the Military Academy was quite different from what it would have been under ordinary college rules and marking. The result has shown that the type of men that for many years have been put in the Corps of Engineers has proved suitable for engineering work. While once in a while a man is a misfit and does not do much as an engineer, the proportion is so small that the wisdom of the men who laid down the course has been very well justified indeed.

It has been quite the customary thing for educators to look at West Point as an antiquated school that does not give an engineering education. Does it? Does it profess to? It cannot. Even in the engineering education that it does give, the course is defective. There is time lost; there is a great deal that we graduates don't know and never will know. I had to confess the other day to the president of one of the most successful of all of our engineering colleges that I had a very hazy idea of exactly what the moment of inertia has to do with the transverse strength of a beam, and he said, "I have, too." There is something wrong about that. Don't you see, gentlemen? But with all its defects, West Point has done

something. Do you know, gentlemen, that the proportion of the alumni of West Point going into civil life who have filled high stations in civil life in our country is greater than that of any other institution in our country?

Now, why is this? It certainly is not a broad education that West Point gives. Nobody claims that. It certainly is true that cadets do not get a thorough understanding of all that is taught, and I could make other confessions. But West Point must do something or it could not give the results it is giving to the country. And what is that something? I think we could sum it up easily. It is, first of all, that there is inculcated in the young man there the idea of duty; that when a thing is to be done it must be done. It doesn't make any difference whether you want to do it or don't want to do it, it doesn't make any difference whether you think you cannot do it; you have to do it, and that is the first thing that is pushed into them and pushed into them for four years.

And then another thing we have there. The young men being graded according to their ability, the tasks that are given them daily are also graded according to ability to get through that task. It is necessary for the young man to put his whole mind down hard on it. He has no time to think of other things; he has no time to go into side excursions of knowledge, no time for other arrangements; the day's work must be done that day, working as hard as he can to get through. If a man is sick in the hospital God help him, because he loses his place in the class, he loses position in the whole of his military life. I have known a man to lose what is equivalent to five or six years in promotion, lose out on his arm of the service, get into a lower grade, because he had the misfortune to catch the measles and be laid up for a little while. You never can make up at West Point. You must stay ahead; you never can make up back studies. Each day you have to do the work laid down for that day.

Now that induces in this young man the ability to concentrate his thoughts on the work in hand. Then along with that

and a part of that is the essential military training of which Dr. Mann spoke. I think there are really very few people in the country, excepting the men who have actually been through it, who know what military training is. Our people have come to think of it as ability to put a gun in certain positions, or the ability to step off together and make a show on parade, and that sort of training. That is not military training. There were thousands of men in the country before the war who could do that sort of thing, who were not soldiers at all. Military training is essentially, as Dr. Mann put it, the acquisition of that self-control that teaches a man where his work is, that makes him do his work as laid down, so that he is only one part in an immense machine which can move, without friction or breaking, towards the end to which it is directed. It is a self-control that must go through the whole life of the man. It cannot be acquired by an hour a day, or an hour a day each week, but it is something a man has to get into him by his whole business of life for years before he gets that true military training, and it is just as essential for civilians, or ought to be, as for soldiers.

Dr. Mann spoke of what the army is. Do you know, if you come to think of it, the army represents the very highest of human endeavor. Where else do we find men working absolutely harmoniously without any lost motion, without any loss of time, toward one single end, with such devotion to the getting of that end that life means nothing to them? To do that requires military training—or training. "Military" is a word we don't like—"militarism" none of us like; but the training that is required for that is the training that will help us everywhere in civil life. You know in our country one of the very greatest things we have to consider in all branches of human endeavor is the saving of time. You take it in the factories abroad or in their transportation system abroad, what they look to is saving of coal; man power means nothing. With us, all our problems must be solved with reference to the saving of men, with the saving of time.

I wish each of you gentlemen could spend two or three days at West Point and see what a wonderful time saver this military system is; how there is no lost motion, how everything that has to be done has to be done in the minimum of time with the minimum of friction; how classes form on the tap of the drum, and the men fall in and answer to the roll call going to the recitation room or going to their studies; and during the entire time allotted for instruction the instructor has no thought of anything excepting the instructions he is giving. There is no difficulty about loss of time in getting there; there is no difficulty about loss of time in getting to the seats, no difficulty of loss of time in trying to hold the attention of the men. It is the most wonderful time saver we have. We are all working for efficiency all the way through. Why is not that efficiency, and if efficiency, why is it not essential for the school—that sort of thing? If we can get that kind of training, the small amount of acquisition of knowledge necessary to pass from the civil to the soldier status is easily attained. That is the kind of military training that I would like immensely to get into all of our schools, and I am sure that if you could ever try it, ever have it, you would deem it absolutely essential.

The War Department was trying recently to make an experiment under impossible conditions. I don't know of any task harder than for a man to go to an ordinary college with a set of undisciplined young men and get that kind of training into them. It requires the highest possible training faculty. Now that training faculty was absolutely essential for the winning of this war and getting the boches killed, because it was needed for training the army to go over there. The result was, the kind of men who ought to have been sent to these colleges could not possibly be spared for that work. I was asked again and again for engineer officers to go to these schools and I had to say that we did not have the men. It was immensely more important to kill boches, and when personally asked by the schools what was necessary for them to

do, I said, "Attend to your instructing, and I will attend to the military end after they are prepared for that by you."

I am in favor of the kind of military training of which Dr. Mann spoke, and I hope and wish you gentlemen would consider that and see whether it would not be possible in your institutions to do that for the good of the institution, for the good of the men, as a time saver. A little later I am going to tell you some more things tending towards time saving.

So much for West Point. Our young men graduated from the academy and came into the Corps of Engineers. They did not consider themselves engineers, but had a good foundation upon which to build. What we did with them in the first year after graduation was to put them with troops and have them learn how to handle men and get a little more military information. After that they are sent back to their books and then sent to the troops and then another year of school, and then to assist on these various public works. So we looked upon the first ten years after the officer entered the service and received his commission as an engineer officer, as being in a manner non-productive years in which he was learning; the officer did good work, but was always considered in a measure non-productive.

After the ten years' training, after the guided or directed schooling in practice on the works or in school itself, then they were intrusted in the care of works. So the training goes on upward. Now, then, I do not see at all why that same training cannot be applied in civil life. I think it a great mistake to try to make specialists of half-baked engineers. You take a man, for example, who has learned mechanical engineering; it should be his natural aspiration to go clear up to the top of that branch of the profession. Now, unless he is an all-around engineer, how can he ever rise to the top, how can he design entire plants, for when you get into a power plant there is found the application of every kind of engineering; there is no single specialty. He is better off if he has this broad foundation at the bottom. So if possible to do so, it

would be infinitely better to take the youngsters at school and put them through your regular course. The course is good; I am going to find some fault with the application pretty soon, but the course is all right. Then let them go out in actual work for a year to get their brains clear as to what they know and don't know, because the boy on graduation is mighty indistinct in his knowledge and knows a good many things that are not so. Then let him come back and specialize, and then see to it that in accepting an occupation after that, he shall accept a position, no matter what the pay is, but a position in which to train better as an engineer, so that his training can become progressive until he is fit to start out for himself. I think this may be rather idealistic. We can do it in the army, and if possible in civil life so much the better. Of course, the engineer must be learning all his life long; and if he ever stops he should go into a box underground.

The supply we could get for the Corps of Engineers from West Point was insufficient. Then Congress authorized us to hold examinations each year and take in graduates from our civilian colleges. This we were glad to do. The first examination we held in January, 1912, and there were four men who applied for it from civil institutions and passed the physical examination. They all failed mentally but we were not willing to let it go at that, so we stretched our consciences very hard and took the best ones in. September 3, 1912, we had another examination. Sixty-six and two thirds per cent. of the men at that examination failed. In 1913, one hundred per cent. failed. In 1915, fifty per cent. in February, failed; in October, sixty-six and two thirds per cent. failed. In August, 1916, eighty-four per cent. failed. In January, 1917, we made the examination as simple as we could and thirty-four and one half per cent. failed. In June, 1917, the failures were eighty-one and one half per cent.; and in January, 1918, eighty-three per cent.

In 1916, after looking over the record, I thought there must be something wrong; so knowing the president of the Virginia

Military Institute, which represents one class of the engineering schools of the country, I asked him if he would put the questions given at the last examination before his faculty and frankly criticize them, so I would know if we were asking wrong or unfair questions. We put the same questions before the faculty of Columbia University of New York City. Both institutions said they were perfectly fair questions, and that any one who had learned the course ought to answer them all.

There is no question about it,—the courses of all the schools cover every question that was asked, and any man who had learned those courses thoroughly should have been able to answer those questions. Consequently, there was the inference that the students do not know what you are teaching; they never get it through their heads, and if that be the case, isn't there something wrong then with the kind of teaching? Is it not the case that after a professor has been teaching a subject for a number of years that subject becomes the end and aim of the existence of that professor, he teaches it as a finality of human knowledge, good in itself and requiring nothing further?

At West Point we were taught mechanics very thoroughly. We were taught it as we might be taught the Apostles' Creed, as a beautiful thing to live up to, but we didn't know much what it was about, and didn't find out until a year later when taught engineering. Then we found it had something to do with that, and, in the meantime, we had forgotten in part what we learned about mechanics. And so all the way through. The candidates of whom I spoke were good men; they came from good schools; they had had a very good course. The trouble wasn't with the men but with the way of teaching.

We have endeavored all through the war not to give a commission to a man as a combatant engineer who wasn't an engineer as shown by a diploma from a reputable school of engineering, or else by having been in practice over five years. No political influence came in play, and we prided

ourselves on that. What was my dismay last fall when I found that they were going to graduate men at West Point after two years when they had had only a course of pure mathematics, and were going to commission them as engineers. I made the hardest kind of a kick and said that we didn't want them as engineers at all, and didn't want them in the corps; but for reasons undoubtedly good I was compelled to take them. So I was loaded down with sixty-two young men bearing commissions as engineers who had never been trained as such.

The next thing was to find out what we were going to do, and the only thing to do was to begin at once training them as engineers. Now it happened that due to the war closing suddenly a number of officers and graduates of the Academy became available, some of them our best men. So the only thing I could do was to form a course for these young graduates using these officers as a school faculty. I knew there were institutions where I could send them, a number of institutions were most kind in offering, but my young men had had a partial military training and I did not dare take advantage of the institutions; I wanted to keep on that military training for two years more.

That gave me an opportunity. I had been reading with the greatest interest Dr. Mann's report shortly before and had found a great many conclusions which he makes in that report were conclusions to which we had arrived in trying to find out why the examination results were as they were. So it came to me that I had a wonderful opportunity to teach engineering, wonderful not only for the sake of these young men but perhaps also for engineering training in general. So a school was started. We have no course in mechanics, we are not going to have any course in mechanics. We tell them mechanics is a very beautiful thing indeed, a perfectly delightful study, if a man has an income and can devote himself to research. But we are going to put up to them a civil engineering problem. We say this problem must be solved.

To do this, certain principles of mechanics must be understood, and as those principles come up in the attempted solution they are taught, not as an abstract science but as a tool which the engineer must learn how to use. And I hope before we are through to get up just as thorough a course of mechanics as is found in any of the schools, to be given in connection with engineering as a tool which a man must learn to use if he is going to be an engineer. Perhaps I can illustrate it.

In mechanics the first subject treated is naturally that of force, and the composition and resolution of forces. In the course at Humphreys the men are taken to a structure where evidently forces are in action, as, for example, a truss bridge. They are then directed to observe the bridge carefully, note its members, their forms, and the materials of which they are composed, and to try to think out why the members are placed as they are, and what fixes the dimensions of the members and the materials of which they are made.

From this follows naturally, a study and discussion of the composition and resolution of forces. This subject is considered first by the students in an apparatus similar to the Atwood machine. The relations of the component and resultant force and the lines of action having been determined by experiment, the algebraic formulæ showing these relations are then deduced.

Similarly a concrete example such as a lock or dam is taken. A model and drawings of the entire structure are exhibited, together with descriptions of the operating machinery. With this concerte example of work done, the problems relating to the forces acting upon the walls and the dam, with the laws governing them, are brought out. Questions relating to hydrostatics and hydrodynamics are presented, and after a study of the principles, the problems are solved. The reasons for the location of a dam, for its height, and for the effects of the dam on the regimen of the stream and on its navigable capacity are also presented.

The machinery of the dam and its motive power present many questions on other lines of work, all of which are taken up in their proper order in the course, and so throughout, the study of the principles of mechanics, including optics, acoustics, measurement of time, etc., is conducted with reference to concrete examples of work that has to be done. The interest of the student is stimulated and the knowledge of the principles is fixed by the immediate application of these principles to practical problems.

I hope by going through the whole course in that way we will get men more thoroughly impressed with the principles, in less time than is taken in studying principles in the schools separately, and cover the whole ground. That is the kind of work we want to do. And I am here with Colonel Peterson to get you to help all you can, on that line, because it is a most interesting experiment. It will be impossible to carry it out under the circumstances in such detail unless we have men who have kept their military training up, so there will be no waste of time and a perfectly clean slate on which to write.

That is what we are going to do, gentlemen. I have made this a longer talk than I wanted to, but this is an interesting experiment; we are going to try it, and we want your help. I thank you very much.

Discussion.

J. C. Olson: I have listened with the greatest interest to what General Black had to tell us, and especially along the lines of the methods used at West Point, which consisted of giving the young engineer something to do every hour of the day, and the result which followed in efficiency from the military point of view, and also the implied criticism of the civilian college of engineering where we do not do anything of the kind and where it is my idea that we should not do anything of the kind.

Now, I do not for a moment question that the results attained at West Point are the desired results from a military

point of view. I do not wish to question for one moment but that it is very desirable for the military engineer to be all things at any time he may be called upon and that he shall be ready to do any possible piece of engineering construction, whether he is fit for it or an expert or not—I do not question that for a moment, and that West Point is as efficient a military school as can be obtained; but the point I wish to raise is that in educating engineers for civilian work, we must be very careful that we do not adopt a military method, for two reasons; I think there are two specific reasons why we cannot go too far in this direction. In the first place, the real constructive inventive work is not done according to the clock; men do not proceed to sit down at a particular hour on a particular day and give you some original idea which is of value to mankind. Those ideas come at entirely unexpected and unspecified times, and the education which forces a man to do work at a particular time, that is not the kind of education which produces originality in men. I need only to cite the case of one of our great inventors who you all know will lose his sleep and meals and neglect every single consideration in his absorption in developing a particular problem. We have had criticism of our own school by students when set tasks to be studied within a limited time, that they are sometimes not ready to study, that their minds will not do their best work, and sometimes they want to keep on until eleven or twelve o'clock at night, that being the way their mind works. Of course, it is possible that there are times when men have to do things at a particular time and in a particular way, but I think there is a great deal of work which men do which they have to do in their own time and way, and if these men are given liberty in that sense they will do a good deal more constructive work than under military discipline.

I want to make one more point, which is this: I think the civilian colleges are specifically designed to produce experts and that it is a dangerous thing to develop the all-round en-

gineer too much. There is a place for the all-round engineer, but there is a different place for the expert, and I think it is a very dangerous thing if engineers get into the habit of doing things they are not specifically qualified to do. I think a man should be trained specifically along definite lines; he should be taught them, not allowed to tackle things for which he has not made proper and due preparation. But I want to say that this is not a criticism of West Point at all, but to point out what seems to me to be a distinct difference in the requirements of education of the civilian college and for military purposes.

M. I. Pupin: Mr. Chairman and colleagues, I am inclined to disagree with the last speaker—radically disagree with him—not a little, but altogether. I have had something to do with West Point graduates and graduates of the Naval Academy. They came to Columbia to do some research work in engineering, and some of that work they did under my direction; and I found them way ahead of anything that I received from universities like Yale and Princeton, or some of the western universities—they were way ahead.

It may be, I must admit, that they were way ahead of the other men from ordinary colleges and universities because they were picked men—I admit that; but I also admit, and I am inclined to believe, that the reason they were way ahead, as far as I can tell, was because they were trained in the way —disciplined in the way that General Black described to us; that is, that they had definite military discipline.

It is a great thing to tell young men that there are certain things they must do whether they like it or not, and do it at the right time and in the right way. We are very deficient in all of the universities, I think, in that respect, and the adoption of a certain amount of that military—which we call "military"—manner—I don't call it "military" because the word "military" does not seem to me very popular nowadays. I call it the disciplinarian method, and our work will not improve until we adopt a certain amount of it.

I do not believe that engineering education is to fit a man to do invention, to do original inventive work. Few students will do that kind of work, and they will do it whether they become educated or not; a man who is a born inventor is going to make inventions in spite of university training; he does not need it—he will make it; he will get his education and knowledge somehow. Engineering schools, it seems to me, are not called upon to take care of men who can make inventions, who have that kind of temperament; they are called upon to produce engineers, men of discipline, men who can do a job the right way at the right time; and that is the kind of men we want, men of discipline.

Now, there is another point—the second point I object to—training specialists; and I object to that more than I object to the first, if that can be possible.

Specialists!—Well, people ask me to-day, "Are you an engineer?" and I say, "I don't think I am." "Are you a physicist?" and I answer, "Well, I don't know; ask my friends, my colleagues, what they think I am." Now, really, I don't know today whether I am an engineer or a physicist or what not. I know that I like to be a scientist; I am interested in science—scientific research, and I don't care whether that research is purely of the scientific kind or purely the engineering kind. Of course, I must admit that I am an extremist in that respect.

Now, can engineering education prepare specialists? I don't think it can, because it is generally said that the few things a man can learn during his four years of engineering are so simple it will take a young man of original mind to find out what he knows—at least, it will take the conceit out of him. It is admitted by the best engineers that I know—and I know some very good ones—that our engineering education should pertain first to the fundamentals before you do anything else, and really, in my experience as a teacher of physics and mathematical physics, and theoretical and electrical engineering—in my experience I find that with the ordinary student,

and even with the student who is considerably above the average, you cannot do much more than to teach him just the fundamentals.

Engineering is an art, and "Art is long," as the poet has said and the gentleman said last night, and "Life is fleeting." And if life itself is short, just imagine how short the engineering course in a university is, and you cannot expect to teach a man an art in a short course of four years that has to take care of the student and attempt to make him a specialist. It is absolutely hopeless. No, we don't want specialists, we want men who know foundations well, and then after they have left the university they can choose for themselves whether they want to become specialists or not. A great many, and I would say the best men I have had under me, do not intend to become specialists at all. They want to be good engineers, and the opportunities that they may get from time to time will determine whether they are going to give attention for some length of time to some specialty or another.

Professor Olson: When speaking of specialists, I would like to ask whether you mean that the man shall be an electrical, chemical, or civil engineer or all three of them.

Professor Pupin: I think labeling each man with a trade mark—electrical engineer, mechanical engineer, and so forth, has done more harm to engineering education than anything I know of.

K. G. Matheson: I wish to make a few remarks on the application of discipline as brought out by General Black. At the Georgia Tech we think we have done some little work, but when the Government placed there one of the aviation ground schools we at first did receive the cream of the teachers such as I had never seen in my thirty years' experience. And the marvelous application of those men was to be simply an eye-opener of the possibilities of the student life. I became profoundly impressed by the work done by those young men and the accomplishments under rules of efficiency; I wish to say that I have had the benefit of being trained four years as

MIAMI UNIVERSITY
OXFORD, O
LIBRARY

a cadet in my boyhood days, and I am exceedingly glad that I had that equipment. Although my life has not been along military lines in any sense, I am perfectly sure I was taught methods of discipline which have been beneficial.

At Longues, where there were twenty-two army schools, half of the picked men of the army being sent there for training (I have General Black's permission to mention the place as the war is over)), and, as stated, I have been a teacher for a number of years—through the kindness of the commanding officer I had access to all these schools and took advantage of the opportunity to see what could be done under stress or stimulus which the war called for; and I was amazed, literally amazed, by what could be accomplished under the stimuli of efficiency and of some particular impelling motive. The young men accomplished there in a few months almost unbelievable things. Of course, I recognize we could not have them continue under this high tension, but it seemed to me it opened up new avenues of thought as to what we teachers could do with our students.

Now, are we going to lose all the lessons of this war, all the high ideals of self-sacrifice and application? If we do, we are not deserving to live in this age. Those lessons of efficiency which these men have learned ought not to be lost but conserved. Many of these men are going back to college and the old slipshod ways. In my own institution, when we have chapel service the men come in singing and laughing and straggling to their seats, and it has been a joy to my heart to see the trim formation of the men going to places, no time lost, ready for business; and I repeat, the work done in those army schools illustrates what can be done with our American youth. Those were American boys such as you and I teach, large numbers of them college men, and with our incentives and typical American ideals and characteristics we do not wish to spend the time; our teachers do not wish it any more; we got deadly tired of the S. A. T. C.,—the faculty more than the students.

Now isn't there something we can do without having the extreme West Point idea on the one side or upon the other the slipshod, inefficient procedure of the typical American college. As has been suggested by Professor Pupin, why not call this efficiency instead of militarism, and train these young men along efficient lines? All of us know there is something beyond cramming the brain with theories of the textbook. We are training them for life; they will go into business. Their employers will not put up with what we do. Isn't it a mistaken kindness to let them go through upon the methods we have had, generally speaking, in the colleges? I believe myself that we ought to bend our energies toward something of the efficiency plan which these training schools of the war period have illustrated, and we ought to make a direct application in our institutions, and ought to omit our own feelings in the matter, and the well known antagonism of students, to overrule. And I repeat, that if we lose the lessons of efficiency in our colleges such as were taught by this war, we are certainly not faithful to the ideals of education.

I myself was very much in favor of the S. A. T. C. continuing in a modified form until July first. It would have been the first test we could have had in the colleges of this very efficiency of which I am speaking. We could not do it in the war period. The whole idea was to produce officers for the army in France. We had the opportunity from January 2 until July 1 to actually give the men this training, and it would be worth every dollar the United States Government put into it for efficiency, in training helpers who want to be leaders along industrial engineering lines and life generally. That is the best I can say of it, and now the point is whether we are going to do something to take advantage of what we have seen illustrated.

C. R. Dooley: That same thing took place, I think, in 147 schools whereby 130,000 went through, and the value of the discipline is not altogether to the man in charge of the school, because in his own institution the man has the problem of

barracks. The military discipline which has been provided in Section B, not only provided an inspiration and exactness such as Dean Bishop has mentioned, but gave facilities for getting more done in a given time; it created a spirit of accomplishment, of production if you want to call it that; for joy of production, not for piling up the wealth of the country, but merely the joy of expression, and that came from the type of army officer which the school had, which was very far removed from civilian life, and he himself was an inspiration that he held out to these men that this was the way to the greatest accomplishment. It was not exactly the figure of K. P. duty which was always staring them in the face. I could tell you dozens of stories of the work of these 130,000 of men were trained in entirely different from their daily experience. A class of East Side New York garment workers and bums was far removed from educational ideals. In six weeks there came back reports of blacksmithing produced by those men which was perfectly wonderful; and last Thursday I went over to the Dickinson High School and they showed me piece after piece that these boys had made. Also the same thing that they buy from the factory, and you can tell the piece made by the boys, it was infinitely more accurate and a nicer job than the standard production.

That thing has gone on all over the country. As President Matheson said, what he saw in France has been done in our institutions. It is perfectly marvelous. Go to some of these schools, investigate the experiences these men have gone through and see what has been done, which would have been absolutely impossible except for this discipline. Don't call it military, but inspirational, because it appeals to these young men in production. In a very few short weeks there have been great results, and it has been a wonderful experiment and is something we must carry on.

C. R. Mann: There were perhaps a few remarks this morning that call for some comment. The question of general and specific training was discussed and various ideas brought out,

one being that I was a great specialist, which seemed to be an implication of an argument for specialist training. Although I do not want to go into my autobiography, I would say that I went through college and spent nine years studying Latin and Greek and various things of that kind; also I spent a number of years learning to be a physicist, and taught physics for a great many years. Then I got interested in education, and that is quite a long call from physics to education. But the conclusion that I was a trained specialist in college does not hold at all; all I learned in the colleges was Latin and Greek, a little mathematics, and generally things of that sort. I think the same is true of Professor Pupin, whom I used to work under in Columbia. He was a graduate of Columbia, went abroad several years, and became an expert physicist. His specialist training took place after his college training.

Now, the issue is confused by the fact we haven't yet gathered the full implication of the war experience, because before the war, as you all know, our educational gatherings spent their time in discussions upon certain details; and we were divided into two schools, as usual. You know there have always been two schools, as Professor Hadley said, even in Noah's time—the diluvians and the antediluvians. It was so always; always divided into two schools on all sorts of minor points. That is, those who thought that the solution of education consisted in putting the real and practical before the theoretical, and others believed the theoretical should go first. I have now reached the conclusion that it does not make any particular difference, provided the boys want to do it. The fundamental point is to get the boys to want to do it. Sometimes it is advantageous to go from the theoretical to the practical application and sometimes from the practical application to the theory, all depending upon the skill of the teacher; in the individual it does not produce the effect if the boys really want to do it.

Now, the same is true with reference to this question about

the general engineering and specific engineering, and it is perhaps fortunate that this discussion takes place in Boston, because Boston is not a place at all. "Boston is a state of mind," and the engineer, in the same way, is not a specific individual in any way; the engineer is a state of mind, and the important thing is to get that person into the state of mind that is typified by the word "*engineering.*" There are different ways of doing that, and each school will find a different way, depending on the personality of the student, local conditions, the personality of the professor; and therefore we are not in a condition to lay down any general law with respect to the training except one—and this is the burden of my song.

We have all been amazed at the speed and intense success of the military training program all through, not only in the officers' training camp, but in the general and vocational encampment. Everywhere we have been amazed always at the speed and effectiveness of it, and we have said it was very noticeable the last two weeks—said it was due to the war spirit—the spirit of patriotism; and the minute the war ended there was a noticeable slump in the S. A. T. C.—the spirit of it. That shows us clearly that the only thing we can all agree on as the fundamental thing to try for is the same kind of *spirit*—and the problem is to transfer that war spirit of patriotism to a peace spirit of patriotism. Now, that puts a new face upon the educational problem, because it is not a question of intellectual methods, whether you go from amplification to theory, whether mathematics precedes science or vice versa; none of those old questions that we used to talk about at these meetings, but simply the question how to get the right spirit, and is it possible in times of peace to get the same sort of national spirit of service or anything like it that has developed in this time of national crisis?

Now, if we can get it, and it seems to me there is no theoretical reason why we cannot get it—if our young men have the spirit of national pride and service, and have them go to

work in business with the same spirit as in war; if we can get that same emotional reaction, that is the question rather than any manipulation of administrative methods that we may devise here in all wisdom, and that is, I think, the fundamental problem before us. I think it is personally not only thinkable, but easily possible, to develop a national spirit of service in peace time, similar or perhaps as powerful as that which had its birth in time of war. And if we can do that we solve the problem, no matter of what kind of teaching methods we employ.

The problem, therefore, is an emotional problem, not an intellectual one. We have been talking about it all these years as if it was a problem in intellectual gymnastics, but you won't get a man fired with patriotism by any method of emotional gymnastics. So it is policy to recognize that it is also an emotional problem—a problem of setting up conditions that will appeal to the young man and make him feel inspired to real work and achievement and accomplishment for the national service. And I think the best line to follow in those conditions is a line of activity, namely, the line that deals with production. That is the fundamental keynote of our situation for the next twenty-five years; are we going to be able to produce not only goods, but men equal or superior to the men or goods in other nations, and how are we going to do it effectively? Young men are eager to express themselves in production, and the emphasis is not on mental discipline or training of the mind; the emphasis is on learning to do things for the benefit of the community in which they live. Therefore the machinery consists in each school of studying very carefully the immediate needs in detail of the industries and the general situation in that community to find out what to do to make that community a better place to live in, to increase its productive capacity, to make it a healthier community, not only in terms of material good, but in real human welfare. I think you can get communities interested in that sort of thing for their own sake, and in that way develop a

spirit of community service, state service, and national service which will have a similar emotional effect to the effect of the war service.

Therefore, I would like to raise the question as to whether that is not, after all, the hub of the situation. It is no question whether the engineering school or the ordinary college have drills or otherwise; whether it shall teach mathematics by Euclid or some other form of geometry, but the question is whether you have the right spirit. Therefore we can gauge our educational discussion as a result of the war so as to include in its catalogue of operations the development of an adequate and refined national patriotic spirit; and I believe it can be done, and I am sure this Society will take hold of it from that point of view with great enthusiasm and great success.

A. L. Williston: I was very much interested in the two papers or addresses of this morning by Dr. Mann and General Black and the discussion which followed. It seemed to me in the discussion of General Black's address to a certain extent some of us lost sight of what we had in mind in this matter of military training. Forgetting the definitions that they both suggest, as I grasp the real essence of military training that has done such marvelous things during this last few months, it is not anything more than duty—an extraordinary willingness to make sacrifice, even to the extreme sacrifice, in order that that duty may be accomplished with a hundred per cent. perfection.

That is the essence of military discipline, and how any of us can have any difference of opinion as to whether that should be a part of after-war education is beyond my comprehension; and how any of us, either, can have a different opinion as to whether the methods that have been so extraordinarily successful during these months may not be useful in peace time in producing the qualities of character that we all have taken a part in forming. It seems to me it goes without saying that there is something very definite that can be

learned from this experience, that can be incorporated into our systems of education.

There is a second point that General Black touched on—didn't dwell on, perhaps—that has not been referred to in connection with a part of this military work. I was at a meeting of mechanical engineers in New York and was much impressed by the paper of Mr. Wolff, on scientific management, in which he called attention to the fact that the best results that had been obtained were by appealing to the students to use their minds while they worked. If that is true, and if the general idea which he brought forward is true, that the best results are reached when mind and body are used simultaneously, then isn't there a lesson to us out of this military experience, namely, a fuller, better and more perfect physical development of the scientific with the intellectual? I think the response we have got from the efforts of these young men in these military times has been possible because of the wonderful physical development that has brought, first, physical enthusiasm, and then followed by mental enthusiasm as almost supplementary, or a sequence—the two things are almost of necessity complementary, it seems to me; they are methods that go hand in hand.

I was interested, too, in General Black's analysis of the combatant engineer, the statement that he came to be an all-round engineer prepared to meet and successfully solve any kind of problem that he was ordered to undertake. It seems to me that we are all of us combatant engineers, and that we have got to be prepared to undertake, at least, a wide range of business problems in life, and that there is going to be a good deal of uncertainty about those problems. Hence we have got to come with a broader conception of our calling and an understanding of a great variety of applications of the principles of engineering.

But I was interested also in his method of solution of that. He stated very clearly the goal he was after—the target he was shooting at. Then when it came to the sixty-two young

men who came to him, he gave us a picture of the gun that he was going to use to reach his target. It wasn't general and visionary, entirely outside the range of both the interest and the comprehension of his sixty-two young men. His method of attack was to take concrete problems, not necessarily in hydraulics, I take it, but problems that were difficult problems, that were comprehensible to the young men of the age and experience that he was dealing with, but nevertheless real. One of the essential things, it seemed to me, in that method he gave as an illustration, was that the methods of education he was going to use there were methods that had reality, and it seems to me that the word *reality* is one of the things that gives us the key, at least, to the success all the way through of this military training program. And in carrying forward his instructions he was going to draw from that program things which had reality, and which had appealed to the interest of those young men—broad general principles, and he showed their application to a wide variety of other problems.

One point I, perhaps, would differ with Dr. Mann in the subject last discussed—I think really not with the point that he had in mind, but with the impression his remarks gave. He suggested that it made no difference whether the practical precede theory or vice versa. I think he will grant that it does to this extent, that theory can only precede practice where theory can be so presented as to come somewhere within the range of both the life experience and the interest of the individual who is to take it; and unless we can organize our theory so that it does that, then must follow the presentation of such practical problems as General Black gave.

Now, in nine hundred and ninety-nine cases out of a thousand we are dealing with the young and immature and have no background of real experience upon which to base theories unless we present to them in some such fashion practically real problems and draw our lessons of theory and practice from them.

The question of specialization versus general training is very largely one of difference in terms. Nobody, it seems to me, is interested in the kind of specialization that is not based on a broad foundation, of a thorough understanding of principles that may be applied in a wide variety of ways. But the danger, it seems to me, is when we agree that we shall avoid that narrow specialization. We are too apt to swing the pendulum over to the other extreme and say it is glittering generalities which have no reality.

In closing, I want to express my gratitude, and I believe the gratitude of the great majority of this Society, to General Black for that concrete expression he gave us of the way to accomplish the broad training through concrete and practical methods.

V. C. Alderson: I have come a long distance and I have yet to find out what I came here for; I have yet to learn the purpose of this meeting. I do not mean in general terms, I have heard that, and heard some very interesting talks; but I thought yesterday, as I listened to our English friends, that they had a method of their own which we Americans did not adopt, and that is the direct method. And I have decided I would take that as the first thought I would express to you, and I believe we ought to adopt that method immediately. If we all came here, as I did, with the idea that universal military training was to be introduced, and that we were going to do the patriotic thing in our engineering schools and aid the Government in the War Department, if that was our purpose, then we should take some direct action here before we leave, in order to bring that about. But I learned a few moments ago that perhaps that wasn't the plan, that perhaps the plan was for the War Department and the Government to do this training by themselves. If so, I am still in doubt, and more greatly in doubt as to why we are here.

Now, if the Government by itself has the purpose to do this engineering work by establishing more West Points or doing the work all by itself, Congress will pass the legislation at the

suggestion of the War Department and we shall have nothing whatever to say about it. But, on the other hand, if we in the civil institutions are expected to do something, if the Government expects to use our institutions to provide a supply of men who may in future be of use to the army, then there is work before us. It is my idea that if that is the purpose of the meeting, if we are to join with the War Department, we ought to know it explicitly now, and if such is the purpose, we ought to be informed as far as we can be at the present time to just what extent we should have to introduce military drill, and to what extent we might expect to change our courses of study so as to conform to the needs of the War Department—change our courses of study to provide what our young men ought to know and carry into private life and be able to use in case of need. If the latter is the purpose of the meeting, I think before we close the discussion we ought to appoint a small committee, a committee of men who would agree before their appointment that they have the time, means, and willingness to coöperate closely with the War Department, and that course here means General Black, and, if necessary, go to Washington on call at the invitation of the War Department to confer with them; and also appear before the House and Senate committees on military affairs to inform them from the civil point of view just exactly what we can do, and make sure that legislation is put on the books, of such nature that we can all come in and do our part. Pardon me, gentlemen, for being so direct, but specifically I should like to have General Black or some one else tell us why we are here and what we ought to do, if anything.

President Hayford: Before I call on General Black, I think I ought to say a word on my own behalf and not merely as your presiding officer—especially in a case like this where the inference is (kindly enough) that we are here for one purpose while ostensibly here for another, or at least the purpose of the meeting is misunderstood, which makes it all the more necessary for the president to make a statement.

If anybody will look at the literature promulgated before this meeting, it seems to me that it is clear that this meeting was to meet the British Educational Mission and exchange ideas with them, and that commission was not on the face of it or in fact a military commission. It is the meeting of that British commission coming here in time of war to study conditions here, but those conditions are educational conditions, not primarily war conditions. If General Black will pardon me, I think I can sense the feeling of this Society and put across what I understand to be the real situation in a very few sentences. General Black made a clear distinction between the combatant engineers and those further back from the fighting line, the S. O. S. group, the engineers that carry supplies, those that deal with transportation, the construction of water works, and other problems back of the fighting line. I think I am interpreting him right when I say that his view of the training of the military engineer is that he is preeminently to be a combatant engineer, and that he believes that the training for S. O. S. service and other engineers is primarily a civilian proposition and wants it to go ahead in future as in the past; but he thinks the function of the United States Government in connection with engineers is to develop combatant engineers and, as I understand it, he is not thinking of any other kind of coöperation at present in the colleges of engineering, but in developing new and greater schools in place of the ones formerly at Willett's Point for the graduate work of West Point men who become engineers, and some school at the Washington barracks; it is a new and better school of that kind which he has in mind. If I have not interpreted the General aright, he has an opportunity now to make a better interpretation. I am trying to put it to you, sir, in your own terms what the purpose of the meeting was, and also what is the relation of General Black's proposed school to our schools.

General Wm. M. Black: You are quite right, and I am glad to answer what I understand about that matter; but I want

to speak of one or two other things first and add to some of the things which Dr. Mann has said so much better, and which the succeeding speaker has put so strongly to you.

When at West Point there was a little man in my class fond of practical jokes, and he would get something off on almost every classmate. We were never able to get back at him because we could not worry him at all. He was a very popular fellow and has since risen to great eminence in the military career. Finally, when I was off on a furlough, I heard a bit of Sunday-school doggerel which happened to fit the case capitally—

> "Happy little Stumpy Wood,
> He always did the best he could.
> Let us follow Stumpy's plan
> And always do the best we can."

And then it stopped, because it *was* Stumpy's plan, and we got it on him in good shape, so that he became so exasperated that, picking out the smallest man in the class, he said, "I want to hear you get that off, because I am going to lick you and I cannot lick anybody else."

But, gentlemen, I am quite in accord with Dr. Mann and the succeeding speaker in the belief that what is needed and what we should do is just what we have been doing in this war, the development of the highest sense of duty. If you can get that into the man, that whatever they are doing is their duty, and it is up to them to do that with all their might always, you will have what you want, and you will get the essence.

Now, military training simply develops that and carries it out, and then puts a little machinery in to show how the whole thing will work more coördinately and smoothly. But that is the essence. If you can get young men to come to school for a purpose and learn to be true to themselves, true to their family, and their country, they carry out that purpose—in other words, get that sense of duty and act on it,

and then you will have the spirit that will make it possible to do anything. That we must instil into our young men if we can.

One gentleman this morning spoke about invention and about the necessity for the inventor to go off and dream and evolve the bright idea, and then come down from heaven and place it before the world. There is not one of you who has been educated in a great engineering school who has not been compelled to invent, no engineer who has had a great work to perform that has not had to make improvements on existing methods. They don't come from dreaming, but in doing the work and seeing how each can improve on what has gone before.

We have had the other type of invention or inventor to deal with, and you may thank your stars—all except Professor Miller—that you haven't had anything to do with it in this war. Professor Miller has had, and the Department at Washington has been simply swamped with the other kind of inventions—things called inventions, because they were new to the inventor; but things thought of by Alexander the Great and his generals a long time ago. Much time of the men in Washington and in the United States at large has been consumed absolutely uselessly in this war by so-called inventions, and a bigger nuisance than the ignorant inventor never walked on two legs. I say "ignorant" inventor, because almost all these things result from the fact that the man didn't know engineering history and he didn't know military history, the conditions of engineering as existing at the front, nor the conditions of the war; so he would come along with things that looked very good to himself and his friends. Professor Miller has been through it, and we all have down there in Washington.

Now, that kind of invention is utterly of no good to humanity. Edison doesn't work them out that way; he has had certain problems and has been doing his best to solve given problems, and in thinking them out his original mind took a

step farther than any one else has done. That is invention; that is the way inventions in the world come about.

I spoke about making specialists, and subsequent speakers, Dr. Pupin, Dr. Mann, and others, have said that specialists are needed, but for heaven's sake! don't let them specialize until they know their business, until they have such a clear appreciation of everything leading up to that specialty that they can specialize and do work for the world. The other kind of specialist reminds me of a story that happened some time ago. I went to a very prominent sanitary engineer one day, whom I knew very well, and asked him at what stage of his career a man could call himself an engineering expert. He replied, "Just as soon as he can charge forty dollars a day and expenses and get away with it." That is the way with a good many specialists of the other kind, we don't want them. A real specialist has a broad knowledge of his profession in general and then goes ahead on a particular line and works out something good. We all have to be specialists at times. We have to be specialists in making inventions, we have to be specialists in making steps forward, but the best step for the benefit of the world and the best way to do our share towards paying the debt we owe to our predecessors in engineering is to go right ahead and develop in any work the thing that comes up, and go a little further if we can than had been done to date, and we all have to do it.

Now, in regard to this meeting. The president is entirely correct. Neither Dr. Mann nor myself came to ask anything in particular of the schools in regard to the immediate needs of the War Department. I happened to mention this morning that for the Corps of Engineers in all human probability we shall have to call on the engineering schools of the country each year for a certain number of men for our Corps, and I tried to describe the kind of training we would like to have those men receive. Then my other remarks on that were somewhat in the hope that we could increase the comprehension of our young men as to the fundamentals of engineering,

and I told you of my doubts as to the moment of inertia and also that I had found that other men had their doubts, that there are a lot of these principles only partly comprehended. They are not so abstruse that you cannot learn them at all, but simply that they are not presented in such a way that the young man can get hold of them, because their interest is not excited or they are presented in such a way that they cannot quite grasp them. And if we could improve our methods so as to get that better, it is simply a saving of time, getting more done in the same time.

Now, gentlemen, if you will look over the courses you have all been through, you must recognize that there are at least four or five years of a young man's or a young woman's life wasted. Consider one thing, for example. For the first seven or eight years of a child's life he is worried with arithmetic. Generally he doesn't get much out of it. I think I must have been twenty-one years old before I fully comprehended why, in multiplication, you set the figures as you do. There are a whole lot of things of that kind, and when you get on a little further you feel exactly as if, in putting you through that long training on arithmetic, you had been given an axe and told to chop down a tree with the blunt end of it; because you find a little further on that you have been given an exceedingly poor tool. Others are infinitely better, and you wonder then why those who had charge of your education made you work years and years in learning processes you simply turned into the scrap heap. Why not teach mathematics? Why teach arithmetic, algebra, trigonometry and all the rest separately, and not use all progressively as the more intricate computations are reached, using for each class of problems the mathematical process best suited for it? Why not give a proper tool to the child at the moment when he can use it? Children are scared at algebra because told it is advanced mathematics, but it comes nearer to the child's attainments than anything I know of, because it is a beautiful game of make-believe all the way through. Why make a bugbear of

algebra? Why bother with cube root and the higher roots by arithmetical processes? Nobody would dream of using them. Take the algebraic methods and learn logarithms and you dismiss all those stumbling blocks which simply discourage young students. What's the use?

Now, let's take that right into our higher education. Stop teaching a lot of things. It is like giving a child a certain number of treasures which he puts in a box and sets them up in the cupboard, and says, "I am through with them," and when he hunts for them he has lost the one he wants the most. Why not make it a progressive system from the beginning right straight through, and then we will get what we want. You know in our country, by the time a man reaches twenty-one to twenty-two years of age he must be self-supporting; therefore you cannot give more than so many years for the fundamental training. Then let us become sufficiently efficient in our educational methods to enable us to give in those years before twenty-one or twenty-two the training he needs. It can be done, and it is simply up to us to give way to proper efficiency methods. If we get them, and then instil that sense of duty, and its practice all the way through, we will get the product we need for the nation, and the product that is needed for the world.

Professor Olson: I think you will permit me a word. It seems to me I have started something. There has been a great deal of objection to what I said, but I think there have been a lot of good things said since I made those two points and I agree most heartily with what General Black has been telling us, and with what other speakers have said. Of course, I had no idea whatever that the man should dream and present his dreams as something that was born complete. I realize as well as anybody that the matter of invention is a matter of hard work; I have done enough development work myself to realize that after ideas come it takes hard work to make them practical.

But the point I made is this, and I don't think anybody

has touched it in the discussion, and that is under the military method as we had it in the S. A. T. C., the young man was given definite hours of study and just exactly the number of hours in which to do his work, and it appears to me that for the civil college, no matter what is true of the military, that that plan will not result in efficiency so far as study is concerned. I may be wrong, but that is my belief, and I think more discussion should be devoted to that phase of the subject. The student does better work when he is put upon his honor, when his interest is developed, and when not told specifically that he must study from seven to nine or any other particular time.

I believe in the promptness of military work. There is no one more irritated than myself if a man or a class comes in at intervals of two, three, or five minutes. I believe in starting on the minute and closing on the minute. I am in sympathy with the military regimé which when it says eight o'clock means eight o'clock; I absolutely believe in that. And I think we can get a great deal out of this if we will insist upon that in regular college work. I think it is going to be an improvement and will help us very much, indeed; but when it comes to study, if a young man is told to get his lessons and put time enough on it—then let him work his own time, as long or as short as necessary. When I was in college, some lessons could be prepared in half an hour and others in three hours, and I never found in my experience that fixing a definite period for class work was the right thing; if I had the details of getting the subject, that was the point.

And the same idea in original work. I do not think General Black speaks about any definite hours, that the work is in mind and it has to be done, no matter what the hours are and how much time it takes. Now it appears to me that the young man doing civilian work is not going to be under the same military rules in his work. I think the same thing will be inculcated if he is given more freedom, and with that freedom he will do better work than otherwise. I am very much

in sympathy with the present concrete problem that is on the board in front of us; I think that is a very great thing; I think there has been too much of the theoretical. On that point I am with the practical, that is, with the concrete and the definite aim in education.

As to specialization, I have in mind whether we are going to drift back again towards general engineering education, or whether the policy should be taking the freshman class uniformly in all courses and then dividing it into various groups. Is that the proper procedure, or is it not? Have we gone too far in that direction, and shall we come back again? Now I do not think those two things have been discussed, and I would like to hear others on those two points.

C. F. Scott: One of the first statements in regard to Dr. Mann's address this morning, one to which I might take exception, was that experience of the S. A. T. C., that it was too short to give us any lessons or give us experience that we could draw conclusions from. Short as it was, and unsatisfactory in many particulars on account of that shortness, there are, I believe, certain lessons which we can learn, and I have noted two or three points which I suggest to those present may be brought out this afternoon. One is in the supervised study the reaction on the teacher. The teachers have come in contact with the student during his study and preparation period and have got a new viewpoint of the difficulties of the student, upon the way he is studying and have found out some of his mistakes in his methods of studying, and have come to realize more that the preparation period is something the professor should keep in his mind in teaching students how to study as well as calling upon him to recite.

From the standpoint of the student the supervised study has given to many a new notion of concentrated definite and earnest work in a measure that they have not had before. We have had, in addition to our regular undergraduate students, a number in the officers' training group of the Signal Corps. They have been men from various parts of the country, and

some of them have told me that this concentrated training they have been getting has given a new notion of study; that they had not been good students in the first years of the college course; that some of them left when halfway through college, but if they go back it will be with a different point of view; and I think the same reaction has taken place in the undergraduate students.

In connection with the S. A. T. C. and war work we have had a splendid example of one of the things that Dr. Mann puts forth in his report, namely, the value of interest as an incentive to work. What happened at the time of the armistice simply reinforced that whole proposition, that the interest and incentive are the strongest things we can have in education, and Dr. Mann has done us a splendid turn this afternoon in suggesting some methods by which that interest can be continued in the future. Incidentally, at a meeting of one of my classes last week, I put the proposition to them that the change we are going to make from the S. A. T. C. to something else was one that might well occupy their attention, and asked them if they would not like in the discussion next week to take up the questions of the last few months, what they had gotten out of it as students, and what things we had had in this late experience that should be continued and would be valuable; that it was a very important matter to them as Juniors to find out what methods of work during the next year and a half would be of the most value to them and have important bearing on their careers through the whole of their lives. They took an interest in it and said they would like to discuss it and will report in a few days after reviewing the situation.

Dr. Mann stated that one of the purposes in the educational training of engineers was to train them for the handling of national problems; that one of the great difficulties the past year or two—in the aircraft, particularly—has been the handling of industries on a large scale; we needed nationalization. The attempt of a great many in the industries of the

railroads has been to bring that about, and the business of the Government for many years has been to prevent that; the Government for many years undertook to separate the railroads. Take, for example, the Union Pacific and the Southern Pacific. It got that organization, which ranks as showing the highest efficiency of operation, and one of the highest in operation from the point of safety in the country—separated, and then the Government came to undertake the same problem of national transportation which the railroads had in a measure recognized, it immediately called together the very men they had tried to put in the penitentiary for doing these things, put them at the head of the men to operate those two railroads on a national scale; and that wasn't enough, but they took over the railroads themselves to operate them by some of those very men whose railroads had been separated. Now, Dr. Mann, you mean to say that we should train men as engineers to teach them to operate in the industries, particularly the railroads and thereafter become criminals in the United States? It is to be hoped that Congress as well as the engineers can draw some lessons from this war. In point of discipline, this new method which we found so efficient in many ways, how to continue that in the future is a problem. Strict discipline, holding the young man to a definite course, has many admirable features; it keeps the student from doing wrong; it strengthens them in certain good habits, but when those surroundings, limitations, and rules are removed the man may not have the strength of self-control and self-dependence which he would have had if they had been cultivated during these periods when he has been protected. There are dangers both ways—too much protection and of not enough. Where shall we draw the line? How far shall we go, and what instrumentality shall we use in the college with students in the future to continue this desirable disciplinary method? That is one of the large problems which is before us, a problem which the stopping of the war has made greater than that of starting it; the problem of getting

back into a new life of the future, one which probably is as important for us to solve and solve right as that of getting into the war right.

Some of the things said this afternoon reinforce this proposition which is one that I would have presented anyhow, that somehow the problems of peace on the conduct in the ordinary life of men in overcoming and solving the problems of living, of overcoming problems which nature presents and solving nature's problems, are those which should involve some greatness of ability and preparation to work out, the same as the emergency problems of war. If we are looking forward to general usefulness and proper development of the race, war is simply preventing a catastrophe, but the constructive building comes in the future, and the keynote of the problem before us is to get into the state of mind to cultivate men's interest in something definite and tangible and real which is going to make our schools not ideal, not general and vague and indefinite, but concrete and real. A good deal of this discussion between that which we term, on the one hand, as generalization, of course is specialization, or as broad engineering training against specialized training, or as ideal versus the real, comes down really to the difference between the abstract and the concrete. We don't want to be so general that we are vague; we don't want to be so special that we are training as specialists and artisans. We want to lay the foundation in broad training, to get that broad training not by going into the vague, the abstract, the theoretical, the ideal, but by combining that and learning those things through that which is real, concrete, specific, and which the diagram on the blackboard is a good illustration of.

President Hayford: If Dr. Mann has anything to say as to why he advises men to become criminals, perhaps we should like an explanation from him.

Dr. Mann: The case Professor Scott presents is the very case of the fundamental problem that the engineering world has to face, and I purposely have so far avoided discussing

that because I did not want to confuse engineering with the local issue. However, if you want my personal opinion in that matter, I will be glad to give it.

There was a significant statement in the aircraft report, in the summary, which says that the criminal statutes do not reach cases of inefficiency and therefore these gentlemen are all absolved. Now, in the case of the railroads, it was found that the engineering solution of the railroad problem was diametrically opposed to the legal solution of that problem a few years before, and the most interesting question, it seems to me, before the country so far as engineers go is the adjustment we have got to make between the legal solution of difficulties of that sort and the engineering solution.

Now, the legal solutions, it seems to me, were made to prevent people from doing certain things. They were negative. They were not there to encourage efficiency of the railroads, to make them serve the nation better, but those legal restrictions were placed there to prevent people from doing certain things that the country considered to be unfortunate from the legal point of view. Therefore all I have to say is that the antithesis that the engineers must make in the next few years between the legal solutions that have been put forth and the engineering solutions that must be forthcoming is going to present a very interesting field of activity for engineers; it is going to get you into many very inspiring arguments and discussions.

Now, that point I have not dealt with in my report at all, because again I do not want to confuse strictly the educational issue with what is the very fundamental issue in industry—the issue of whether the industry is to be controlled by legal enactments in the interest of those who hold the title to the plant, to the tools, the legal title, and those who understand how to use those tools. I don't want to confuse that issue with the strictly educational issue, but it is there and you will have to deal with it sometime, and it may appear, therefore, that some engineering solution that we adopted

primarily in the war—because the engineering solution is the one for production—may contravene what has been set aside as the legal solution for the difficulty.

Edward Robinson: There is a thought that has come to me in listening to this discussion this afternoon. We all, I think, can agree that we want to get the splendid disciplinary training which the military training gives. We want first that vigorous health, that erect form and splendid physique; we want clear thinking and fundamentals and all that sort of thing, and this military training has succeeded, to a certain extent, in doing that. But it seems to me it emphasizes a very great lack, and we all want to clearly look at that lack, in our whole educational system, and that is that the time to do that is not to begin it in our colleges. You can take a piece of cold iron and hammer it into a given shape, but if that iron is heated you can hammer it into that shape much easier.

Now, the time to begin this military discipline, that care of the body, that personal development, is when the boy reaches his social stage, that is to say, when he is from twelve to fourteen years old; so that by the time he gets into college those habits will be thoroughly formed, and I believe we college educators have got to look at that side of the matter and in this reorganization that we are trying to bring about also try to work for this discipline down in the lower schools; because if we can get it down there, we can save enormously and make our work tremendously more efficient.

Now, General Black has suggested something under that line in the matter of teaching arithmetic. I know perfectly well that to a boy of fourteen algebra is much more interesting than arithmetic; I have simply been through that experience in the last few years with my own boy. The same thing is true of the teaching of language. The time we waste on arithmetic in those lower schools, if we put it into good and thorough training in the spirit of language by letting the child study his Latin and his other languages, he would get

that language training that he never gets afterwards—if he does not get it at that time. I believe that we want to get that spirit of the military that we have all seen. We have seen these boys get out of college and go into the training camps and come back splendid specimens in a short time. But there is no reason why we should not have most of those fine and vigorous personalities when they enter college, and if we can develop their interest it seems to me we have got to start down below; and that in this Government committee, if it is going to hold on to some of these things, we must consider the earlier type of training, too.

Dr. Mann: I forgot to answer another one of the questions asked a few minutes ago, but I do want to answer President Alderson's question about the control of schools from any central federal agency, or the request of the Government in regard to what schools can do—any organization that might be effected further on in the work of our committee or any other committee that might be established. Because I think it is very clear to every one in Washington as well as here that any form of Federal control or federal dictation of our national institutions in the country would be a mistake. It would be undemocratic and a very dangerous thing to do, therefore I don't believe that Congress will take any steps in regard to universal training that will impose upon the school system of the country any restriction. The school system of the country must be controlled locally and by the states in order to be safe, and I am quite sure as far as our committee is concerned we have no idea whatever of trying to prolong the guidance or the control of the schools placed in our hands for a few months on account of war necessities. In times of emergency you can do that for a short time, but it is not safe for a general policy.

Now, it is not proposed to train schools entirely without any advice. We are planning and hoping to be able to carry out a project of gathering together the vast mass of material which exists there in Washington of experience with this

work, showing the type and problems that have had to be solved and met by engineers, and perhaps it is possible to get that material printed and distributed to the schools for their information, and the schools can do as they like with it, there can be no possibility or desire of "Thou shalt" going with it. That makes it perfectly clear, to my thinking, that the progress of engineering education and the development of the nationally thinking engineer is squarely up to the schools. The Government has no authority to take control in that matter. That is my own personal opinion in the matter, or it is the opinion of our committee if you like. It is not, of course, Federal judgment in the matter.

So it seems to me that all ought to think of it, not as a matter that the Government is going to assume the responsibility. It is going to be the Government's place to guide and solve this problem and tell you what to do. Not at all. The problem is squarely up to the schools; on them rests the opportunity; upon them comes the burden, and upon them rests the responsibility, it seems to me, of finding the solution.

President Alderson: The reason why I put my question sometime ago is this: In the state of Colorado there were three institutions that had the S. A. T. C., and in the first one the president of the institution was told that he had nothing whatever to do with running the institution; that the commanding officer had to do that. He remained, however. In the second institution the second president was told that he didn't have anything to do, and the matter was reported to Washington, and the officer was removed. The same thing happened to me; I did the same, but the S. A. T. C. died and he is still there.

So far as institutions are to do this educational work in aiding the War Department, I want to know, first of all, what the contract is going to be; I want to know if the army officer is going to interfere with the academic work and report only to the War Department. Tell us who is the head of the institution. Do the trustees, the faculty, or the president

amount to anything, or whether he is going to be a member of the faculty and subject to the rules of the trustees?

Now if there is going to be any military instruction in the engineering school, I think the status of the army officer should be distinctly marked out. In Colorado we have had a very bitter experience, and if I were to be asked at this meeting whether we wanted any military instruction, I would ask if it is going to be under the S. A. T. C. or on our own account. If it is going to be for harmony and good feeling and work for our common interest—yes. I think that matter is a vital one, that anything done by the War Department with reference to the engineering schools should be looked at as a vital matter and taken care of. For instance, the exact status of your commanding officer, and I speak from bitter experience. In the latter part of September I knew of the status of a second lieutenant, a man with no training or culture and no judgment, who was sent to our commercial institution to command everything in sight. If that is the kind of a man we are going to have in the future, I don't think we want any military instruction in the school. But if we can have harmony and a gentleman of experience in training, willing to coöperate with us, then I think we ought to take hold and help the War Department.

It was with that idea in view I asked the question, Why are we here? Let me say that the printed instructions in regard to this meeting are very clear, but our British friends have gone, and you will remember we were to devote this afternoon to this Reconstruction topic. My question still holds; will somebody answer it? Is this work to be carried on by the Government alone, or are we in the engineering schools to be asked or commanded to come in, too, and if so, how?

President Hayford: I would suggest that the answer of the group is being given in a very successful discussion; all the discussion, both this forenoon and this afternoon, shows what the sentiment of the group is.

R. C. MacLaurin: I cannot get away from attempting an amusing statement—amusing to me, anyway. For years when I was a youngster I wanted to be a general, but I got over it. Now, for the last four years, I have certainly wanted to be a soldier, and since the eleventh of November I have gotten over that; but since hearing President Alderson's statement about whippersnapper lieutenants who were able to talk saucy to college presidents, I am on the band wagon again.

President Hayford: Earlier in the discussion the idea came up several times that a real military training is very valuable as a means of promoting efficiency, and I am tempted to suggest that Major Gilbreth, who looks at things from the point of view primarily of efficiency, should tell us in a few minutes what he knows about it.

F. B. Gilbreth: I am glad that he said a few minutes, because that is the only thing that can stop me.

At this War College I worked with two or three very fine young men who were trying to put the one best way into moving-picture films, and they tried to standardize the one best way of the best teacher. You have been talking a lot about pupils, and in their behalf I desire to talk about their teachers. I think you are a sorry lot; I think that you do not dare to face the facts; I think this is a mutual admiration society, where you come together with the idea of stealing half of the wrong idea from each other. I dare you to come out and agree on some one single thing; reduce this problem to those points where we can agree and then let's argue one point at a time.

Discipline. I will tell you why you haven't got any discipline over your boys. They are "on." In the army they may be "on," but they don't dare to stay "on." They are "on," that is why you haven't got the discipline. When the boy absolutely believes that his teacher is right, there is no trouble about discipline, and if you have a definite scheme of presenting before those boys the one best way on minute things so far as you can agree, the discipline will take care

of itself. If you wish to try out some discipline, go into the entertainment room where there are a few rogues and roughnecks and talk to them on a military problem and see what will happen to you. I had that experience at Fort Sill and got away with it, and I will tell you why. We took a picture and put it on the screen, and we had a projector which wasn't merely a projector for motion pictures but one that would also permit you to stop on any one picture, permit you to run backwards, and permit you to treat the consecutive snap shots as lantern slides. And I said to these young men that I had a long experience in recording the one best way and these pictures were made by experts in their particular department and these pictures had been shown to competent officers and revised by the best men and improved under their criticisms and they would be good for them to see, for sooner or later they would go to France and would like to know these things. They didn't haze me at all. They took me into their confidence and wanted to talk it over. I laid myself liable to a terrible hazing because I was neither a military man nor a mechanic.

Now, if some of you don't start in on this scheme of the recording of the one best way so that the rest of us may have a target to shoot at, as one speaker has said, I shall do it myself—in fact, I have already done it. These pictures at Fort Sill are so good they have been copied by a number of people, but they are not entertainment moving pictures, and they are not the so-called educational moving pictures.

In this matter of recording the one best way and in standardizing it, that is a trade in itself. We have got to have experts in that work. I brought it to the attention of this society six years ago—naming the possibilities of it without going into the details, and I have now got a thousand feet of film. I notice your long list of committees, but I see nothing that resembles a committee on the standardization of the one best way, or anything that suggests that the whole scheme of teaching engineering consists in the perfection of its parts. I

agree with the previous speakers that we should give them a broad education so they may be in a condition to do as a friend of mine was willing to do who was offered a job in Alaska one summer. I asked him if he could do that particular form of engineering. "Where is it?" he asked. "In Alaska." "Oh, yes, I can do any kind of engineering in Alaska." "Why?" And his reply was—"It takes eight weeks to get to Alaska."

Anson Marston: I am afraid you will think it is frivolous when I tell you what it was. I told him I thought I could illustrate the war in education by influence on the educator. You will note this uniform which was made by a tailor, and I will state that I measure three quarters of an inch taller than I did when I went into the room; I hope that the war will have the same effect on engineering education, that it will bring it into stricter limits of the essential things—shrink it, for instance; and that it will place it on a higher plane.

W. G. Raymond: I do not recall whether any one has said anything in favor of the S. A. T. C.; if any one has, I thought perhaps I would like to roast the army a little by speaking in favor of that organization. We had the usual experience in Iowa; we had a rather incompetent commander, we had incompetent young lieutenants in charge of our companies, and we had the influenza; we had over a thousand men sick and thirty-one lost. We had to establish our own kitchen arrangements, and it was supposed to be our own fault in not being able to obtain sufficient labor, so that our men had to do kitchen work.

At times I thought the institution was a military post, so that the men had to do general police duty, which took considerable time and a considerable number of men, and the men didn't get to classes when they should at times. But in spite of that, during the last two weeks, particularly after the signing of the armistice, when most people thought we would go to pieces, we had the best work from our students I have ever known our institution to have in the time I have

been there. There wasn't any question about their appearance, no trouble with discipline; they appeared in the classes on time, and during the study periods assigned they were in attendance and they studied, they were interested in their work, and there was no difficulty whatever, and the general atmosphere of the institution, in my judgment, was much superior to the atmosphere that has prevailed there in previous years.

Now, in regard to what is coming—I don't know what Professor Olson's question was which seemed to refer to what might develop in a military sense hereafter. I can only answer that we have had military training in the school for a good many years and very successfully. We were particularly pleased with its development under reserve officers for the training corps, and we expected to continue after the manner of the S. A. T. C., and we hope that it may be even more distinctly military than it was under the former organization.

Colonel Peterson: I have very little to say. I told Dr. Hayford coming up on the train that I wasn't coming for the purpose of making speeches telling how this education should be done. I have been so busy during the time, trying to get information, that I have not thought of anything I might say this afternoon. I realize this S. A. T. C. has got a lot of unfavorable comment accorded to it. No one seems to care to stand up for it. I don't know as I care to say anything concerning that, only it was a very difficult situation both for the army people and the college president, and it was unfortunate for the army officers that the matter was forced upon them; and the officers called back from the service, when not familiar with it. I am sure it was quite as distasteful to them as to the college authorities. It is a very difficult proposition to handle—very difficult to discipline men when under your control for only a short time. There are many things that make it difficult to handle also when you share the responsibility with people that do not thoroughly understand what

you mean in the carrying out of the proposition. I think that is all I have to say.

President Hayford: We have a few minutes left to continue the discussion.

Professor Scott: Weren't we to have a part of our meeting devoted to the matter of research?

President Hayford: That is naturally a part of the reconstruction problem.

Professor Scott: From some things said this morning, I feel there is a good deal more I would like to hear on the subject.

President Hayford: I think it would be interesting to those of us here to have some discussion on that question. Is there any one who wants to take up that matter?

Dean Marston: The meeting which was called in the other room was called by President MacLaurin, to consider some legislative proposition to establish engineering experiment stations by federal aid. At the meeting the Smith-Howard bill, which is now before Congress, was read and discussed by Professor Pupin from the Research Council, who offered a modification of it. The bill proposes federal aid from each of the states to be distributed to the amount of $15,000 per year; afterwards to be increased to $30,000 per year, as determined by the Legislature.

Professor Pupin proposed a wider measure, a modification of it, by which a board of scientific men would be created in each state to direct the use of the federal funds which would be according to a plan by which individual research men might be endowed or research be carried on at specific institutions.

The meeting was for a general discussion which was very active, and a very significant addition to the meeting was made by President Hobb who presented the view that it was as vital to all the schools as to the engineer. The meeting closed by adopting a general resolution favoring federal aid for research and aid of as practical a character as possible.

If there are any questions, the president of the Georgia School of Technology is here, for it was by legislators in his state that the measure was introduced into Congress; there are also present Professor Howard and others.

Dr. Mann: Who controls the thing in Washington?

Dean Marston: The Smith-Howard bill in the Bureau of Standards modified by Professor Pupin.

Principal Williston: Isn't it important that the Society as a whole should endorse the resolution? It would have more weight in going before Congress. I would ask Dean Marston if it is not desirable for us to hear the resolution and opportunity be given us to add our endorsement to that of the committee.

President Hayford: If that should be desirable it can be readily done.

Principal Williston: I would make that as a motion.

President Hayford: This movement started at least two years ago, possibly three—at least two. It was under active discussion; there were special meetings held to discuss it, and there has been a considerable amount of discussion of it outside this Society. There has been little or no discussion of it inside the Society. It seems to me, therefore, that putting it as a question to this Society for us to take action as a society would be to take action on something we have given very little consideration.

K. G. Matheson: The resolution was of a very general character. It didn't favor any particular bill or any amended bill, but simply was as has been stated, that those present favored federal aid to engineering research stations, and that the best bill possible to be presented was the bill that this gathering favored.

There are to be, as I understand, several meetings of engineering societies next week, at which this whole question will be very carefully considered, and it will be exceedingly important for this body as such to put itself on record as favoring federal aid to such legislation, without reference to

any particular bill. It would not require a great deal of discussion for us to put ourselves on record in regard to it.

(A motion is made to that effect and Dean Raymond reads the resolution adopted at the noon meeting as follows: "The Society for the Promotion of Engineering Education, now assembled, expresses its approval of Federal aid for engineering and scientific research in the United States.")

(This in the form of a motion was presented to the meeting and a unanimous vote was passed in favor of endorsing the resolution.)

Mr. Whitney: This question is a large one which cannot be discussed in open meeting successfully; it is a matter for study, for careful investigation; it is a matter for public information; the public have got to be informed, so that if any of you can write and get it before the general public, that will assist in getting it before the United States of America. And there is one thing that Mr. Gilbreth said which has made me say what I am saying to-day. The more highly educated the individual is, the more difficult it is to get a group of men down to doing the practically obvious and simple things, and the tendency to postpone difficult things to some other time. We see difficulties on all sides, and cannot we get together and agree on some fundamental scheme, postponing the more difficult things, and then we shall get ahead.

EDITORIAL.

We are gradually returning from our various war occupations, or from teaching under abnormal war conditions, to our regular work in the colleges of engineering of the United States. By October, 1919, the colleges will be in full and normal operation with students attacking their problems with renewed vigor and in many cases with an awakened and keener vision of what they may get in college. The coming year brings an unusual opportunity to tone up and strengthen engineering education.

The war conditions and war experience have shown us but few things that it is advisable to imitate in our colleges. But the novel conditions and experience have stimulated thought. We have seen old things from new directions. Many virile suggestions as to possible improvements in engineering education have come to us.

At the Boston meeting of the Society for the Promotion of Engineering Education and the British Educational Mission in December, these things were increasingly evident. Though the program was radically changed by accident at the last moment, the discussions, necessarily impromptu in character, were vigorous. At the end of the two days of formal meeting a mere passing of the word that such a gathering would occur brought together two dozen men who exchanged ideas informally and freely for three hours on that last evening. Those three hours revealed to every man present new views, a new vision of how our thinking had been stimulated in such wise that now is evidently the best of times to discuss our common problems.

The Mann report on engineering education has appeared opportunely, just when war conditions have helped to jar us loose from set ideas. Its suggestions fit well as a rule with the war suggestions. No doubt this report will be studied and

discussed much between now and June in our various separate college groups.

The war experience and the Mann report considered deliberately for a few months, the automatic tendency now to reconsider old conclusions, and the opportunity in 1919–20 for a college life of renewed vigor, all furnish a basis for a June, 1919, meeting of the S. P. E. E. (probably at The Johns Hopkins University) that shall be the best for years in live discussion, in informal exchange of views between formal meetings and in renewed acquaintances.

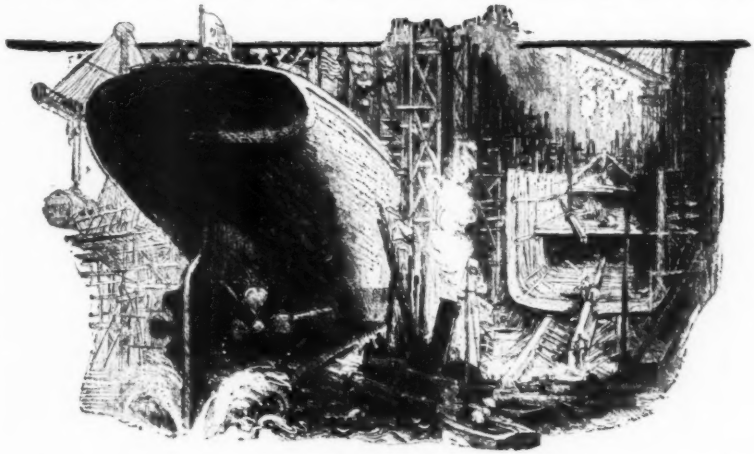
You ought to know what others are thinking. Others want to know your conclusions.

This Society is unique in the vigor and directness with which it deals with the problems of college education,—perhaps absolutely unique in the United States in dealing with the fundamental problems of college education as distinguished from college administration.

Make your decision now to attend the June, 1919, meeting of the S. P. E. E. Let us gather new strength and inspiration there to help us in our endeavor to make engineering education the best college education to be had in the United States to fit men for service.

THE OFFICERS OF THIS SOCIETY HAVE OPPOSED INCREASING THE DUES, ALTHOUGH IT HAS BEEN SUGGESTED BY VARIOUS MEMBERS AT DIFFERENT TIMES. IF EVERY MEMBER PAYS HIS DUES PROMPTLY THERE IS NO NECESSITY FOR SUCH ACTION. IF YOU HAVE OVERLOOKED THIS MATTER, WILL YOU NOT ASSIST THE SOCIETY BY SENDING YOUR CHECK TO THE TREASURER, MR. W. O. WILEY, 432 FOURTH AVENUE, NEW YORK, N. Y.?

Every electrical engineering and manufacturing facility of this company has been applied "without stint or limit" to the vital business of winning the war



"More Ships!" and Electric Power shapes forests into hulls and masts

America becomes a maritime nation overnight. Shipyards have sprung up like mushrooms. It is a race against time, with every day counting. The construction of wooden ships is largely a problem of lumber and labor. Electric power responds.

Electric logging engines go into the forest's depths and bring tons of timber to railroad sidings and river. Electric log hoists and carriages, lumber stackers and conveyors, handle logs and lumber with less labor and in less time than required by old methods.

Big electric motors and controllers are dispatched to the lumber mills to operate band and head saws, slashers, trimmers, edgers and planers, making new records in lumber production.

Lumber for ships is not the whole story. The call for more cantonments and barracks, spruce for aeroplanes, workmen's houses and additional shipways comes at the same time. Powerful cranes and hoists, necessary in both steel and wooden ship construction, must also have electric power equipment.

Look for this—
the mark of leadership in electrical development and manufacture

Many are the problems in control and motor application. Industrial engineers and managers place their needs before the General Electric Company, whose engineering and manufacturing facilities are broad enough and big enough to give the answer in record time, so that the great war program may not be interrupted.

It is for America's manufacturing and industrial efficiency that such an organization as the General Electric Company is maintained. It is to the interest of the country as a whole that industry avail itself of the opportunity to consult with the industrial engineers of the General Electric Company; for many a perplexing production problem can be solved by the correct application of electric power—sometimes without adding to the present electrical equipment.

95-20

GENERAL ELECTRIC COMPANY

This immensely valuable catalogue sent free on request

A DESCRIPTIVE LIST OF

TECHNICAL BOOKS

Prepared by a Committee of the

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION

This is a reprint of the list issued in 1905, with a supplement consisting of newer books recommended by EDWARD F. STEVENS, Librarian of the PRATT INSTITUTE FREE LIBRARY.

The above list includes but a small portion of our extensive stock of technical and scientific books. We invite correspondence with this department of our store, and also recommend our MONTHLY BULLETIN OF NEW BOOKS, giving descriptions of all new books both general and technical, which will be sent free to any address.

A. C. McCLURG & CO.

218-224 South Wabash Avenue CHICAGO

THE NEW ERA PRINTING COMPANY

LANCASTER, PA.

is prepared to execute in first-class and satisfactory manner all kinds of Printing, Electrotyping and Binding. Particular attention given to the work of Schools, Colleges, Universities and Public Institutions

Books, Periodicals

Technical and Scientific Publications

Monographs, Theses, Catalogues

Announcements, Reports, etc.

All Kinds of Commercial Work

Publishers will find our product ranking with the best in workmanship and material, at satisfactory prices. Correspondence solicited. Estimates furnished.

THE NEW ERA PRINTING COMPANY

951. Captain of Engineers with seventeen years experience, seven of these as head of electrical engineering department, is open for fall engagement, west preferred.

Leaders of the World!

It is one thing to *take* the lead; quite another thing to *hold* it!

Weston

Electrical Indicating Instruments

were the first exponents of the Art of Electrical Measurement as it is known today. But of far greater importance is the fact that since the beginning substantially every advance in the Art has originated with this Company and found its first embodiment in this Company's Instruments.

Weston D.C. Miniature Precision Instruments

are masterpieces of electrical and mechanical workmanship. They are accurate, dead-beat, extremely sensitive, effectively shielded and legible.

The group includes Voltmeters, Ammeters, and Volt-Ammeters, both portable and switchboard, of various models and ranges, which offer a selection from over 300 different combinations. Battery Testers are also included.

WESTON ELECTRICAL INSTRUMENT COMPANY

3 Weston Avenue, Newark, N. J.

New York	Boston	Chicago	St. Louis	San Francisco	Miami, Fla.	Minneapolis
Philadelphia	Richmond	Cincinnati	Detroit	New Orleans	Toronto	Winnipeg
Pittsburgh	Buffalo	Cleveland	Denver	Seattle	Montreal	Vancouver

And in principal cities throughout the world

All of W. S. Franklin's books on Electrical Engineering and all of Franklin and MacNutt's books (except **General Physics,** McGraw-Hill Book Co.) have been taken over by, and all orders for these books should be addressed to

Franklin and Charles

Publishers of Educational Books

BETHLEHEM, PA.

Of special interest to Teachers of Physics

Mechanics and Heat . . . . Price, **$1.75**

Elements of Electricity and Magnetism . . . . . " **1.60**

Light and Sound . . . . . " **1.60**

} A three-volume treatise on Physics by Franklin and MacNutt.

General Physics A one-volume Physics Text by Franklin and MacNutt. Published by McGraw-Hill Book Co. Price, **$2.75**

A Calendar of Leading Experiments, Franklin & MacNutt Price, **$2.50**

Professor H. S. Allen reviews this book in **Nature** for December 5, 1918, under the caption "Goods for Physics Teachers," and he expresses the opinion "that most teachers will find the most stimulating part of the volume to be the humorous interludes, criticisms, and questions with which the book is filled from beginning to end."

Elementary Statics (Mechanics)

Franklin & MacNutt, in paper covers . . . . . Price, **$0.50**

Simple Tables for Students of Physics and Chemistry

Price per 100, **$?.50**

Our Electrical Engineering Books may be of interest to physics teachers who give elective courses in Applied Electricity.

Complete book list sent on request.